

Southwest Fisheries Science Center  
PO Box 271  
La Jolla, CA 92038

March 2, 2001

## FINAL CRUISE REPORT

VESSEL: NOAA Ship *McARTHUR*, Cruise Number AR-00-06;  
Southwest Fisheries Science Center (SWFSC)  
Marine Mammal Observation Cruise Number 1616

CRUISE DATES: 28 July - 9 December 2000

PROJECT: The *Stenella* Population Abundance Research (STAR00) project was a marine mammal assessment survey conducted in the eastern tropical Pacific ocean (ETP). The survey was carried out with two vessels. The activities of the other vessel, NOAA Ship *DAVID STARR JORDAN*, are covered in a separate Report.

### FOREIGN PARTICIPANTS:

Instituto Nacional de la Pesca, México (INP)  
Instituto Oceanográfico de la Armada de Ecuador (INOCAR)  
Instituto del Mar del Perú (IMARPE)  
Armada Nacional - Direccion General Maritima, Colombia (DIMAR)

ITINERARY: The cruise consisted of five legs with four- to six-day port calls between each leg. Research was conducted in the international waters of the ETP and in the coastal waters of Mexico, Costa Rica, Panama, Colombia, Ecuador, Peru, and France (Clipperton Island).

28 JUL	Depart San Diego, CA
28 JUL - 25 AUG	Leg I
25 AUG - 30 AUG	Honolulu, Hawaii
30 AUG - 29 SEP	Leg II
29 SEP - 05 OCT	Puntarenas, Costa Rica
05 OCT - 25 OCT	Leg III
25 OCT - 29 OCT	Callao, Peru
29 OCT - 14 NOV	Leg IV
14 NOV - 18 NOV	Panama City, Panama
18 NOV - 09 DEC	Leg V
09 DEC	Arrive San Diego, C

## OBJECTIVES:

The project was a multidisciplinary survey with the primary objective being to estimate the abundance of dolphins affected by the ETP purse-seine fishery for yellow-fin tuna, *Thunnus albacares*. The survey's design targeted the depleted stocks of spinner dolphins, *Stenella longirostris orientalis* (the eastern stock), and spotted dolphins, *Stenella attenuata* (the northeastern offshore stock). Additional data and samples were collected in order to characterize the physical and biological characteristics of the ecosystem. This year's survey was the third and final year of a three-year (1998-2000) study.

## STUDY AREA:

The study area extended from the US/Mexico border, south to the territorial waters of Peru, bounded on the east by the continental shores of the Americas, and to the west by Hawaii (roughly from 30° N to 18° S, from the coastline to 153° W, see Fig. 1). Past studies indicate this region encompasses the entire distribution of the dolphin stocks most affected by the fishery. This area is approximately the same as that covered by the 5-year Monitoring of Porpoise Stocks (MOPS) survey conducted by SWFSC between 1986 and 1990. The study area was divided into three sampling strata which received different levels of survey effort: the core area, the coastal area, and the outer area (Fig.1).

## PROCEDURES:

Cetaceans were surveyed using line transect methods. Observers maintained a visual watch during daylight hours (approximately 0600 to 1800) using two 25 X 150 power "bigeye" binoculars mounted on the port and starboard sides of the ship's flying bridge. An auxilliary 25 X 150 binocular was mounted on the flying bridge for periodic use during sightings or making bird counts. Binocular height above the water was 10.4 meters, giving a maximum ship-to-horizon sighting distance of approximately 11.5 km (6.2 nm).

Six mammal observers rotated through three watch positions: port binocular, data recorder, and starboard binocular. Observers shifted positions every 40 minutes. At least one identification specialist with previous experience in the ETP was on watch at all times. The observer at the port binocular surveyed the area between 10° right and 90° left of the trackline. The observer at the starboard binocular surveyed the area between 10° left and 90° right of the trackline. Thus, the area 10° to either side of the trackline was covered by both observers while more lateral regions were covered by one observer or the other. Using unaided eye and 7X binocular, the data recorder searched the entire 180° forward of the ship, with effort focused on the trackline and the area from the ship out to about 400 meters (the "blind" area in the 25X).

The data recorder entered sighting, weather and effort information into a laptop computer on the flying bridge using the software program "WinCruz", developed at SWFSC. The computer was linked to the ship's global positioning system (GPS) to record time and position.

For each marine mammal sighting, bearing (using an azimuth ring on the binocular mount to measure angle) and distance (using a reticle scale inscribed in the eyepiece) were recorded, along with the initial sighting cue. Schools were approached if they were within three nautical miles perpendicular to the trackline. Observers identified cetaceans to species/stock when possible, and made independent estimates of school size. If more than one taxon was present, percent composition for each was estimated, also independently by each observer.

Seabird observations were conducted concurrently with mammal observations using strip transect methods. A single bird observer recorded identity and behavior for all seabirds within 300 m of one fore-quarter of the ship. Mammal observers on the bigeyes detected feeding flocks within 3.7 km (2 nm) on either side of the ship, and the bird observer recorded size and species composition using either the third bigeye binocular or handheld 20X binocular.

Taxonomic identification and position of sea turtles were recorded when they were sighted. Turtles close to the ship's trackline were captured using a small boat. Captured turtles were measured, weighed, and flipper-tagged. Blood or skin samples for genetic and hormonal studies were collected. All turtles were subsequently released unharmed.

Cetacean tissue samples for genetic analysis were obtained on an opportunistic basis using hollow-tipped darts fired from a crossbow. Samples were collected from the bow of the ship or from a small boat.

Photographs of cetaceans were taken from the ship and from a small boat in order to verify stock identity and to document geographic variation. Individually identifiable whales were photographed for population studies.

Two methods of passive acoustic monitoring of cetaceans were employed: sonobuoys and a towed hydrophone array. Sonobuoys were deployed near cetaceans to obtain acoustic recordings that could not be successfully recorded by the array. Sonobuoys received in the frequency range of 10 Hz – 2.5 kHz (Type 53 sonobuoy) or 10 Hz to 20 kHz (Type 57 sonobuoy). The towed array was monitored continuously during daylight hours. Recordings were made of all cetacean detections.

The behavioral responses of 11 stocks of 8 species of dolphins and 11 species of whales were observed relative to the survey vessels. Data collection emphasized dolphin schools and focused on behaviors that would indicate reactions to the vessel. The data included information on (1) group behavior, (2) school size and shape, (3) reactions to the research vessel and (4) an estimate by the observers of whether the overall reaction of the school to the research vessel was evasive, non-evasive, both, or unknown.

Dipnet sampling for flyingfish and other surface organisms was conducted for one hour at night (approximately 2000-2100 local time) concurrently with the evening conductivity-temperature-depth (CTD) station. Additional sampling was conducted for an hour before sunrise on Legs 1 and 2 during the morning CTD. Small fish were captured and kept alive for aquarium research and display.

Micronekton biomass between 0 and 500 m depth was measured using active acoustics with a Simrad EQ50 echo sounder and two hull-mounted transducers. The echo sounder was operated at 38 and 200 kHz, and interfaced to a data acquisition system. The EQ50 was operated continuously, except on alternate days in the core area east of 120W and north of 5N, when the transducer was turned off in order to test whether transmission affected dolphin behavior and sighting rates.

Oceanographic data were collected throughout the survey. Two CTD stations were scheduled every 24 hours: an hour before sunrise and an hour after sunset. A SeaBird CTD with rosette was used for these stations. From each cast, chlorophyll samples (to 200 meters) and salinity samples (500 and 1000 meters or bottom) were collected and processed on board. Nutrient samples (0 - 500 meters) were collected, frozen, and stored for later analysis. Primary productivity was measured by  $^{14}\text{C}$ -uptake. Three expendable bathythermographs (XBT) were dropped daily while underway at 0900, 1200, and 1500 hours local time. Water samples for chlorophyll *a* analysis and bucket temperatures were also collected daily at 0900, 1200, 1500, and 1800 hours.

In the evening, two or three net sampling stations were conducted: a surface manta tow for fifteen minutes following the post-sunset CTD station, a bongo net tow for 45 minutes to 200 meters, and/or a ring net tow to 200 meters following the completion of the manta tow.

## RESULTS:

Observers visually surveyed 17,377 kilometers of trackline (Fig. 1). A total of 576 sightings of marine mammals were recorded, 488 of which were on-effort. The following tables summarize the data collected.

TABLE 1:	Marine Mammals
TABLE 2:	Seabirds
TABLE 3:	Sea Turtle Sightings
TABLE 4:	Sea Turtle Samples
TABLE 5:	Dipnet Samples
TABLE 6:	Cetacean Biopsies
TABLE 7:	35 mm Hand-held Photographic Effort
TABLE 8:	Towed Hydrophone Array Effort
TABLE 9:	Towed Hydrophone Array Recordings
TABLE 10:	Sonobuoy Recordings
TABLE 11:	Marine Mammal Behavior
TABLE 12:	Oceanography

## SCIENTIFIC PERSONNEL:

Chief Scientist: Dr. Lisa T. Ballance, NOAA, NMFS, SWFSC

Name	Position	Affiliation
Leg 1:		
Lisa Ballance	Cruise Leader	SWFSC
Jay Barlow	Acoustician	SWFSC
Shannon Rankin	Acoustician	SWFSC
Chris Hoefer	Birder	SWFSC
Brett Jarrett	Birder	SWFSC
James Cotton	ID Specialist	SWFSC
Richard Rowlett	ID Specialist	SWFSC
Isabel Beasley	Mammal Observer	SWFSC
Anne Douglas	Mammal Observer	SWFSC
Kathy Hough	Mammal Observer	SWFSC
Ernesto Vázquez	Mammal Observer	SWFSC
Pierre Malan	Oceanographer	SWFSC
Julie Oswald	Visiting Scientist	SIO <sup>1</sup>
Leg 2:		
Sarah Mesnick	Cruise Leader	SWFSC
Megan Ferguson	Acoustician	SIO <sup>1</sup>
Shannon Rankin	Acoustician	SWFSC
Chris Hoefer	Birder	SWFSC
Brett Jarrett	Birder	SWFSC
James Cotton	ID Specialist	SWFSC
Richard Rowlett	ID Specialist	SWFSC
Isabel Beasley	Mammal Observer	SWFSC
Anne Douglas	Mammal Observer	SWFSC
Kathy Hough	Mammal Observer	SWFSC
Ernesto Vázquez	Mammal Observer	SWFSC
Pierre Malan	Oceanographer	SWFSC
Guillermo Jiménez-Bastida	Visiting Scientist	INP
Leg 3:		
Eric Archer	Cruise Leader	SWFSC
Ann Chen	Acoustician	SWFSC
Shannon Rankin	Acoustician	SWFSC
Chris Hoefer	Birder	SWFSC
Brett Jarrett	Birder	SWFSC
Doug Kinzey	ID Specialist	SWFSC
Paula Olson	ID Specialist	SWFSC
Erin LaBrecque	Mammal Observer	SWFSC
Laura Morse	Mammal Observer	SWFSC
Juan Carlos-Salinas	Mammal Observer	SWFSC

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<sup>1</sup> Scripps Institution of Oceanography

## Scientific Personnel (Continued)

Name	Position	Affiliation
Suzanne Yin	Mammal Observer	SWFSC
Dagmar Merkle	Oceanographer	SWFSC
Nelson Fabian-Caro	Visiting Scientist	DIMAR
Leg 4:		
James Carretta	Cruise Leader	SWFSC
Tom Norris	Acoustician	SWFSC
Shannon Rankin	Acoustician	SWFSC
Michael Force	Birder	SWFSC
Chris Hoefer	Birder	SWFSC
Doug Kinzey	ID Specialist	SWFSC
Paula Olson	ID Specialist	SWFSC
Erin LaBrecque	Mammal Observer	SWFSC
Laura Morse	Mammal Observer	SWFSC
Juan Carlos Salinas	Mammal Observer	SWFSC
Suzanne Yin	Mammal Observer	SWFSC
Dagmar Merkle	Oceanographer	SWFSC
Gladys Torres	Visiting Scientist	INOCAR
Leg 5:		
Tim Gerrodette	Cruise Leader	SWFSC
Xenia Brobeil	Acoustician	SWFSC
Shannon Rankin	Acoustician	SWFSC
Michael Force	Birder	SWFSC
Chris Hoefer	Birder	SWFSC
Doug Kinzey	ID Specialist	SWFSC
Paula Olson	ID Specialist	SWFSC
Erin LaBrecque	Mammal Observer	SWFSC
Laura Morse	Mammal Observer	SWFSC
Juan Carlos Salinas	Mammal Observer	SWFSC
Suzanne Yin	Mammal Observer	SWFSC
Dagmar Merkle	Oceanographer	SWFSC
Ruth Bello	Visiting Scientist	IMARPE

Prepared by : \_\_\_\_\_ Date: \_\_\_\_\_  
Mr. Douglas Kinzey, SWFSC  
Biologist

\_\_\_\_\_ Date: \_\_\_\_\_  
Dr. Lisa T. Ballance, SWFSC  
Chief Scientist

\_\_\_\_\_ Date: \_\_\_\_\_  
Dr. Robert L. Brownell, Jr., SWFSC  
Chief, Protected Resources Division

Approved by: \_\_\_\_\_ Date: \_\_\_\_\_  
Dr. Michael F. Tillman  
Science and Research Director, SWR

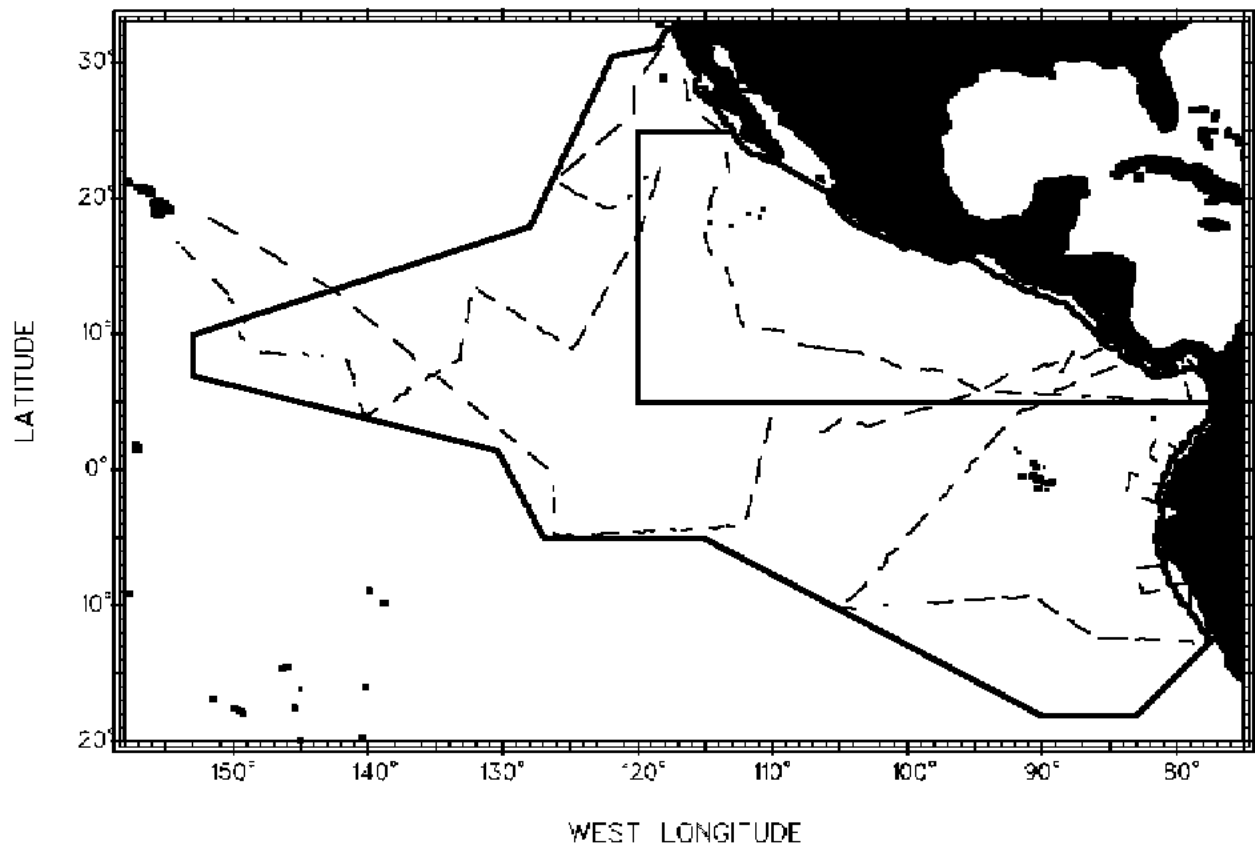


Figure 1 – *McArthur* tracklines (broken lines) and sampling strata boundaries (solid lines) for the STAR00 survey. The smaller box delineates the core sampling stratum and the surrounding polygon defines the outer sampling stratum. A third, coastal stratum follows the 1,000 m contour. The black portions of the tracklines represent the time spent actively searching for marine mammals.



Table 1 – Identity and number of marine mammal schools sighted during the STAR00 survey from the *McArthur*, listed in decreasing order of the number of schools seen. A total of 576 schools were sighted, of which 70 contained more than one taxa and are recorded more than once in this table.

Sighting Category	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
unid. dolphin	18	27	12	13	31	101
<i>Stenella coeruleoalba</i>	16	20	10	9	29	84
<i>Tursiops truncatus</i>	17	9	14	8	10	58
<i>Stenella attenuata</i> (offshore)	23	9	4		11	47
<i>Delphinus delphis</i>	1	6	12	12	8	39
<i>Globicephala macrorhynchus</i>	11	7	6		6	30
<i>Grampus griseus</i>	9	3	4	5	8	29
<i>Stenella longirostris</i> (whitebelly)	19	1	1			21
<i>Balaenoptera borealis/edeni</i>	2	4	4	4	3	17
<i>Balaenoptera edeni</i>	4	10	1	2		17
ziphiid whale	5	2	2	2	4	15
unid. large whale	3	3	3	4		13
<i>Stenella attenuata graffmani</i>			2	7	2	11
unid. small whale	1	3	3	1	3	11
<i>Globicephala</i> sp.			8	2		10
<i>Stenella longirostris orientalis</i>	1				9	10
unid. sea lion	1				9	10
<i>Ziphius cavirostris</i>	1	3	2		4	10
<i>Delphinus capensis</i>				8	1	9
<i>Balaenoptera</i> sp.				6	2	8
<i>Mesoplodon</i> sp.	1		1	5	1	8
<i>Physeter macrocephalus</i>		2	3	1	2	8
<i>Steno bredanensis</i>	4	1	1	1	1	8
<i>Megaptera novaeangliae</i>			1	5	1	7
<i>Orcinus orca</i>	2	1	1	3		7
<i>Stenella attenuata</i> (unid. subsp.)				6	1	7
<i>Stenella longirostris</i> (southwestern)	1	5	1			7
unid. whale	3	2	1	1		7
<i>Zalophus californianus</i>	6				1	7
<i>Kogia sima</i>	5				1	6
<i>Lagenorhynchus obscurus</i>				5		5
<i>Pseudorca crassidens</i>	1	4				5
<i>Balaenoptera musculus</i>				2	2	4
<i>Stenella longirostris</i> (unid. subsp.)	1		1		1	3
<i>Arctocephalus townsendi</i>	1				1	2
<i>Feresa attenuata</i>	1			1		2
unid. cetacean				1	1	2
unid. pinniped	1			1		2
<i>Delphinus</i> sp.				1		1
<i>Kogia</i> sp.				1		1
<i>Mesoplodon pacificus</i>	1					1
<i>Mirounga angustirostris</i>					1	1
Total	160	122	98	117	154	651

Table 2 - Number of seabirds sighted aboard the *McArthur* during STAR00, listed in taxonomic order.

Common name	Scientific name	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
Albatrosses	Diomedidae	3	1	7	146	0	157
Procellariidae							
Shearwaters	<i>Puffinus</i> spp.	2732	991	121	752	1198	5794
Petrels	<i>Pterodroma</i> spp., <i>Procellaria</i> spp., <i>Bulweria</i> spp., <i>Pseudobulweria</i> spp.	2220	953	236	144	66	3619
Diving Petrels	Pelecanoididae	0	0	0	4	0	4
Storm-petrels	Oceanitidae	288	241	947	1475	502	3453
Tropicbirds	Phaethontidae	20	16	10	18	13	77
Pelicans	Pelecanidae	0	0	0	253	361	614
Boobies	Sulidae	30	198	1246	6288	609	8371
Cormorants	Phalacrocoracidae	0	0	0	390	0	390
Frigatebirds	Fregatidae	15	24	65	111	52	267
Phalaropes	Phalaropodidae	1	21	27	8490	197	8736
Jaegers	Stercorariidae	19	47	84	194	48	392
Gulls	<i>Larus</i> spp.	3	0	163	360	358	884
Terns	<i>Sterna</i> spp., <i>Gygis</i> sp., <i>Chlidonias</i> spp.	5348	6304	1021	1230	679	14,582
Noddies	<i>Anous</i> spp.	4	7	46	140	55	252
Auks	Alcidae	0	0	0	0	5	5
Total		10,683	8803	3973	19,995	4143	47,597

Table 3 – Number of sea turtles observed from the *McArthur* during STAR00.

Species/Taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
<i>Caretta caretta</i>	1	1			2	4
<i>Chelonia mydas</i>				1		1
<i>Lepidochelys olivacea</i>	24	4	39	22	26	115
unidentified hardshell	29	1	11	17	9	67
unidentified turtle	2					2
Total	56	6	50	40	37	189

Table 4 - Sea turtles sampled for blood or skin, and flipper-tagged from the *McArthur* during STAR00. All turtles were olive ridleys (*Lepidochelys olivacea*). No turtles were sampled on Legs 1, 3 or 5.

Flipper-tag	Leg 2		Flipper-tag	Leg 4	
	Skin	Blood		Skin	Blood
1	0	1	2	1	1

Table 5 – Dipnet stations and total number of fish collected per leg aboard the *McArthur* during STAR00.

	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
no. stations	31	41	20	15	21	128
no. fish	458	480	339	168	496	1941

Table 6 – Number and identity of cetacean skin biopsy samples obtained aboard the *McArthur* during STAR00, listed in taxonomic order.

Species/Stock	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
<i>Megaptera novaeangliae</i>			1	3		4
<i>Balaenoptera edeni</i>		1				1
<i>Balaenoptera musculus</i>				1	1	2
<i>Physeter macrocephalus</i>				7		7
<i>Tursiops truncatus</i>	3		11	5	1	20
<i>Stenella attenuata</i> (unid. stock)	1			16		17
<i>Stenella attenuata graffmani</i>			1	14		15
<i>Delphinus delphis</i>				2		2
<i>Delphinus capensis</i>				45		45
<i>Globicephala macrorhynchus</i>	6					6
Total	10	1	13	93	2	119

Table 7 - Cetacean schools photographed by hand-held 35 mm camera from the *McArthur* during STAR00, listed in taxonomic order.

Species/Stock	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
<i>Megaptera novaeangliae</i>			1	5	1	7
<i>Balaenoptera edeni</i>	3					3
<i>Balaenoptera edeni/borealis</i>				2		2
<i>Balaenoptera musculus</i>				2	2	4
<i>Physeter macrocephalus</i>			2	1		3
<i>Indopacetus pacificus</i>	1					1
<i>Tursiops truncatus</i>	2		1			3
<i>Stenella attenuata</i> (offshore)	6		1			7
<i>Stenella attenuata graffmani</i>			1	1		2
<i>Stenella attenuata</i> (unid. subsp.)			1	1		2
<i>Stenella longirostris</i> (hybrid)	4		1			5
<i>Stenella longirostris</i> (southwestern)	1	1				2
<i>Stenella coeruleoalba</i>	2	1				3
<i>Delphinus delphis</i>		2	5	5		12
<i>Delphinus capensis</i>				6	1	7
<i>Grampus griseus</i>	1					1
<i>Pseudorca crassidens</i>		1				1
<i>Orcinus orca</i>	2	1	1	2		6
<i>Globicephala macrorhynchus</i>	3					3
<i>Globicephala</i> sp.		2				2
Total	25	8	14	25	4	76

Table 8 - Hydrophone arrays used on the *McArthur* during STAR00, with the dates used. The number of elements, the low and high frequency sensitivity, and the overall quality of the arrays are noted.

Array Name	# Elements	Sensitivity		Quality	Dates Used
		<i>low frequency</i> (Hz)	<i>high frequency</i> (kHz)		
Norris array	5 (4)	15	40	good	Leg 1: 7/30-8/6, 8/9-8/21, 8/24; Leg 2: 8/31-9/3
high frequency array	3	500	150	excellent	Leg 1: 8/7-8/9, 8/22-8/23; Leg 3: 10/6-10/19
ITI array	5	10	15	poor	Leg 2: 9/7-9/9
SEFSC array	5 (4)	15	40	good	Leg 3: 10/20-10/24; Leg 4: <i>all</i> ; Leg 5: <i>all</i>

Table 9 – Number of single species sightings for which acoustic recordings were obtained using a towed hydrophone array on the *McArthur* during STAR00. Non-sighted dolphin schools were listed as unidentified dolphins.

Species/Stock	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
Unidentified dolphin	61	6	11	17	102	197
<i>Stenella coeruleoalba</i>	9	0	4	8	18	39
<i>Physeter macrocephalus</i>	5	2	9	4	7	27
<i>Delphinus delphis</i>	1	0	7	10	7	25
<i>Tursiops truncatus</i>	6	0	3	4	4	17
<i>Grampus griseus</i>	1	0	3	4	2	10
<i>Stenella attenuata</i> (offshore)	4	0	0	0	3	7
<i>Globicephala</i> sp.	6	0	0	0	0	6
<i>Steno bredanensis</i>	2	0	0	1	1	4
<i>Stenella longirostris orientalis</i>	0	0	0	0	3	3
<i>Globicephala macrorhynchus</i>	0	0	1	0	2	3
<i>Delphinus capensis</i>	0	0	0	2	0	2
<i>Psuedorca crassidens</i>	0	2	0	0	0	2
<i>Orcinus orca</i>	1	0	0	1	0	2
<i>Stenella longirostris</i> (whitebelly)	0	0	0	1	0	1
<i>Stenella attenuata</i> (unid. subsp.)	0	0	0	1	0	1
<i>Stenella longirostris</i> (unid. subsp.)	0	0	0	0	0	0
<i>Delphinus</i> sp.	0	0	0	0	0	0
Total	96	10	38	53	149	346

Table 10 – Number of cetacean recordings per species using sonobouys on the *McArthur* during STAR00, listed in decreasing order of recordings obtained. A total of 62 sonobouys were launched, of which 35 were functional. Five "Type 57" sonobuoys (from a total of 16) and 30 "Type 53" (from 46 deployed) operated correctly following deployment.

Species	Recordings
<i>Balaenoptera edeni</i>	8
<i>Balaenoptera musculus</i> <sup>1</sup>	5
<i>Pseudorca crassidens</i>	2
<i>Megaptera novaeangliae</i>	1
<i>Tursiops truncatus/ Globicephala macrorhynchus</i>	1
Total	17

<sup>1</sup> Animals were not heard on every recording

Table 11 – Behavioral observations of cetacean schools recorded from the *McArthur* during STAR00, listed in decreasing order of number of schools for which observations were recorded.

Species	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
<i>Stenella coeruleoalba</i>	16	20	10	9	29	84
unid. dolphin	13	22	11	6	12	64
<i>Tursiops truncatus</i>	16	9	14	8	9	56
<i>Stenella attenuata</i> (offshore)	22	10	4		11	47
<i>Delphinus delphis</i>	1	6	12	12	8	39
<i>Globicephala macrorhynchus</i>	11	8	6		6	31
<i>Grampus griseus</i>	9	3	4	5	8	29
<i>Stenella longirostris</i> (whitebelly)	18	1	1			20
<i>Stenella attenuata graffmani</i>			2	7	3	12
<i>Balaenoptera edeni</i>	3	9				12
<i>Stenella longirostris orientalis</i>	1				9	10
<i>Globicephala</i> sp.			8	2		10
<i>Delphinus capensis</i>				8	1	9
<i>Steno bredanensis</i>	4	1	1	1	1	8
<i>Orcinus orca</i>	2	1	1	4		8
<i>Stenella longirostris</i> (southwestern)	1	5	1			7
<i>Balaenoptera borealis/edeni</i>	2	1	2	2		7
<i>Stenella attenuata</i> (unid. subsp.)				6		6
ziphiid whale	4	2				6
<i>Kogia sima</i>	5				1	6
unid. small whale	1	3	1			5
<i>Pseudorca crassidens</i>	1	4				5
unid. large whale	2	1	1			4
<i>Ziphius cavirostris</i>	1	3				4
<i>Lagenorhynchus obscurus</i>				4		4
<i>Stenella longirostris</i> (unid. subsp.)	1		1		1	3
<i>Physeter macrocephalus</i>		2	1			3
unid. whale	2	1				3
<i>Feresa attenuata</i>	1			1		2
<i>Balaenoptera musculus</i>					1	1
<i>Mesoplodon</i> sp.	1					1
<i>Delphinus</i> sp.				1		1
<i>Mesoplodon (Indopacetus) pacificus</i>	1					1
<i>Kogia</i> spp.				1		1
Total	139	112	81	77	100	509

Table 12 - Summary of oceanographic data collected from the *McArthur* during STAR00.

Type of sample	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Total
CTD casts	48	49	39	29	39	204
CTD chlorophyll samples	475	490	379	281	392	2017
Surface chlorophyll samples	98	117	71	52	60	398
Primary productivity samples	160	161	126	91	133	671
Nutrient samples	524	539	417	305	430	2215
Salinity samples	134	142	115	82	127	600
XBT drops	81	91	57	41	60	330
Manta Tows	24	25	20	15	18	102
Bongo Tows	24	26	20	15	17	102
Ring net tows	9	15	8	9	18	59